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Reducing Approach Bias to Achieve Smoking Cessation: A Pilot Randomized Placebo-Controlled Trial

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Reducing Approach Bias to Achieve Smoking Cessation: A Pilot Randomized Placebo-Controlled Trial

by

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Dedication

To my parents- who sought to instill a passion for education and drive for knowledge from the very beginning. I would not be where I am today without your endless support.

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Abstract

Reducing Approach Bias to Achieve Smoking Cessation: A Pilot Randomized Placebo-Controlled Trial

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This study aimed to provide a preliminary test of the efficacy of a brief cognitive bias modification program for reducing approach bias in adult smokers motivated to quit. Participants were 52 smokers who were randomly assigned to four sessions of approach bias modification training (AAT) or sham training. Participants were asked to make a self-guided quit attempt upon completion of the final training session. Approach bias was assessed at baseline and at the end of each session, and days abstinent was assessed 1-week following the quit attempt. Individuals assigned to the AAT training condition evidenced significantly greater reductions in approach bias relative to those in the sham condition ($p<.001$). Baseline approach bias did not moderate the between-group effect ($ps>.41$); however, higher levels of approach bias at baseline were associated with greater approach bias reduction over time ($p<.001$). Consistent with prediction, the reduction in approach bias during the intervention period was significantly related to the number of days abstinent following the quit attempt ($p=.033$). The present study extends recent work in alcohol use

disorders by showing that approach bias reduction, in this case for smoking-related stimuli, may also facilitate smoking cessation. Clinical and research implications are discussed.

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Cognitive Bias Modification for Addictive Behaviors

Tobacco use remains the most preventable cause of disease, disability, and death in the United States, accounting for nearly 1 in 5 deaths each year (US Department of Health and Human Services, 2014). While most smokers desire to quit, 75-80% of those who attempt to quit relapse (Zhou et al., 2009). The recent guidelines for clinical practice on treating tobacco use and dependence state that, while progress has been made in terms of treatment development and dissemination, there is still a need for innovative, potent strategies for smoking cessation (Fiore et al., 2008).

Dual process models propose that addiction arises from an imbalance between two distinct, yet interacting, systems: the impulsive and reflective systems (Stacy & Wiers, 2010; Wiers, Rinck, Kordts, Houben, & Strack, 2010). The impulsive system relies on associative memory and often operates unconsciously and is difficult to control. Conversely, the reflective system is limited in capacity and relies on symbolic processing and often incorporates flexible learning (Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013a). Friese, Hofmann, and Wiers (2011) have used a "horse and rider" metaphor to describe the interaction between these two systems, such that the horse (i.e., the impulsive tendencies) can be controlled by the rider (i.e., the reflective processes) should the rider acquire the necessary skills and strength. This metaphor underscores the rationale for using interventions like cognitive-behavioral treatment (CBT), which target reflective systems, but also the potential importance of interventions that target the automated, impulsive, implicit processes (Machulska, Zlomuzica, Rinck, Assion, & Margraf, 2016).

Approach Bias Modification

The present study represents a next-step in research testing the efficacy of approach bias modification for smoking cessation. The research was guided by the following findings. First, approach bias, defined as the automatically activated action tendency to approach substance-related stimuli (Wiers et al., 2013a), is an implicit process associated with the maintenance of addiction. The bias has been found in problem users of alcohol and cannabis (Cousijn, Goudriaan, & Wiers, 2011; Field, Kiernan, Eastwood, & Child, 2008) as well as smokers (Machulska, Zlomuzica, Adolph, Rinck, & Margraf, 2015; Wiers et al., 2013b). Second, accumulating evidence suggests that approach bias modification may facilitate therapeutic outcomes for alcoholic patients. Specifically, Wiers and colleagues showed that training alcoholic patients to push vs. pull a joystick when presented with pictures depicting alcoholic stimuli on a computer screen leads to a reduction in approach bias and a significant reduction in relapse at 1-year follow-up (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011; Eberl et al., 2013). Third, in an initial study with inpatient smokers, Machulska and colleagues (2016) showed evidence for an effect of approach bias modification on cigarette consumption, although no evidence for a reduction in approach bias as the mechanism of action. Together, these initial findings suggest that an implicit process like approach bias may be an important treatment target. To develop this application for smoking cessation specifically, it is important to test whether approach bias modification leads to a reduction in approach bias in treatment-seeking smokers and whether such a modification impacts smoking abstinence.

Current Aims

This pilot study aimed to provide an initial test of the efficacy of approach bias modification for engaging the putative treatment target and facilitating smoking cessation. We randomly assigned 52 treatment-seeking smokers to either four sessions of approach bias modification training (AAT training) or four sessions of placebo (sham training) prior to making a self-guided quit attempt. By restricting the intervention procedures to approach bias modification, this initial study among motivated treatment-seeking smokers can isolate the effects of the bias modification program. We assessed approach bias at baseline and at each of the four training sessions and measured days abstinent during a one-week follow-up after the quit attempt, as per recent recommendations for initial efficacy testing for novel smoking cessation interventions (Perkins, 2014). We tested the following hypotheses: (1) persons assigned to the training condition would evidence greater reductions in approach bias relative to those assigned to the placebo condition; (2) initial approach bias would moderate the between-group effect on approach bias reduction, such that the effects would be greater among those evidencing a larger initial bias at baseline, as has been observed in other cognitive bias modification research (Amir, Taylor, & Donahue, 2011); and (3) greater reductions in approach bias would be associated with more days abstinent during the week following the quit attempt.

Method

Participants

Eligible participants were 52 adult smokers (M_{age} = 36.0, SD = 11.8). Participants were recruited from the Austin, Texas community through the use of fliers throughout the community and internet advertising (e.g., Craigslist). Eligibility criteria included: 1) adult daily smoker for at least 6 months (minimum of 8 cigarettes per day); 2) motivated to quit smoking (endorsing at least 5 on a 10-point scale); 3) interest in making a serious quit attempt within the next month without professional assistance or nicotine replacement therapy; and 4) not having decreased the number of consumed cigarettes by more than half in the last six months.

Participants were predominantly White (78.9%), 11.5% were Black/African American, 5.8% were Asian, 1.9% were Native Hawaiian or Pacific Islander, and 1.9% endorsed "other." Overall, participants had a diverse educational background: 19.2% had completed graduate school, 36.5% had completed college, 34.6% had some college, and 9.6% had completed high school. The sample was highly motivated to quit smoking (M = 8.1 [on 0-10 Likert scale], SD = 1.6). Participants smoked an average of 13.7 (SD = 7.1) cigarettes per day. The sample endorsed moderate nicotine dependence as indicated by average scores on the Fagerström Test for Nicotine Dependence of 4.9 (SD = 2.4; FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991).

Measures

Participants rated their motivation to quit smoking on a scale of 1-10 at screen. The Fagerström Test for Nicotine Dependence (FTND; Heatherton et al., 1991) was

administered at screen to examine nicotine dependence. Expired CO was assessed following each training session and at follow-up using a Carbon Monoxide Monitor (Model 3110; Spirometrics, Inc., Auburn, ME).

The Approach Avoidance Task (AAT) in this study was a 15-minute computerized task adapted from Heuer, Rinck, & Becker (2007). Participants were instructed to pull a joystick upon seeing an image tilted to the right and to push the joystick upon seeing a left-tilt image, while ignoring the image content (i.e., implicit instruction). By pulling the joystick (approach), the picture grew in size; by pushing the joystick away (avoidance), the picture shrunk.

In order to assess the level of approach bias at baseline, participants first completed a total of 96 trials in which each of 24 smoking-related pictures (e.g., woman lighting a cigarette) and each of 24 positive images (e.g., group of friends exercising) were pulled and pushed. An approach bias score for smoking-related pictures was computed for each participant by subtracting the average time it took to pull smoking-related images from the average time it took to push away these images. Thus, a positive value indicates an approach tendency toward smoking stimuli, whereas a negative value is indicative of avoidance of smoking images. The bias was also computed for each of the four training sessions. This allowed us to compute an approach bias score at five time points. The task instructions remained the same across all time points. Training sessions are described in detail in the procedure section below.

In order to assess smoking status, self-reported of daily smoking was collected at baseline, throughout the intervention, and at the 1-week follow-up. We employed number

of days abstinent (0-7) after the quit attempt as an index of efficacy. Perkins (2014) has argued that this measure is appropriate for indexing smoking cessation in pilot efficacy testing, because (1) the number of days abstinent during the first week of a formal quit attempt predicts quit status at the end of 2-month and 6-month follow-up (Ashare, Wileyto, Perkins, & Schnoll, 2013); and (2) quitting within the first 1-2 weeks is predictive of long-term smoking cessation outcomes (Ferguson, Gitchell, Shiffman, & Sembower, 2009; Wileyto et al., 2004)

Procedure

Potential participants completed an online prescreen. Eligible participants were invited to the study site for a baseline visit. Upon arrival, each participant received an informed consent form and a battery of self-report measures. Participants then listened to a brief introduction to the tasks. Participants first completed the baseline approach bias assessment, and then they were randomized to Approach Avoidance Task (AAT) Training or Sham Training. Randomization was stratified based on gender and the severity of nicotine dependence using the FTND (0-4 vs. 5-10). The participants were blind to study condition. Study staff instructed participants to make a self-guided quit attempt on the morning following session 4. Participants were told to track their daily cigarette count and were then asked to return to the study site for a one-week follow-up.

Interventions

Each group completed 15 minutes of training on 4 occasions during a 2-week period. The intervention rationale and instructions were standardized for each group and presented via video message.

Participants assigned to the AAT Training condition were told the training may weaken automatic cigarette-approach and strengthen automatic cigarette-avoidance. Using implicit instructions, participants were instructed to pull or push the joystick depending on the tilt of the picture (i.e., right-tilted vs. left-tilted). Each training session consisted of 192 training trials, consisting of 96 positive pictures tilted to the right and 96 smoking images tilted to the left. Accordingly, participants in the AAT training condition were trained to avoid almost all smoking-related images and approach almost all positive images. Each training session also included an additional 24 "training-incompatible" images distributed evenly across the training trials, where smoking images were tilted to the right and positive images to the left. We used the final 6 incompatible smoking-related trials to calculate an approach bias score for each training session (in addition to the baseline score). The bias score was computed for each participant by subtracting the average time it took to pull smoking-related images (the final 6 incompatible trials of each session) from the average time it took to push smoking-related images (96 trials per session). As at baseline, positive values indicate a smoking-approach tendency, whereas a negative values indicate a smoking-avoidance tendency.

In order to create comparable expectancy effects in both conditions, we also provided participants in the sham training condition with a highly plausible rationale. They were told that the training would weaken the automatic tendency to approach cigarettes by improving control over this automatic tendency (e.g., learning to ignore urge to approach and respond only to task instructions) and that following the training, they would be easily able to approach or avoid regardless of image content. Participants in the sham condition

were instructed to pull or push the joystick depending on the tilt of the picture (i.e., pull right-tilted vs. push left-tilted). Instead of avoiding all smoking-related pictures, however, participants in the sham condition pulled and pushed all pictures equally. This yielded 96 training-compatible trials (48x push smoking, 48x pull positive) and 96 incompatible trials (48x pull smoking, 48x push positive). There were no additional incompatible trials, therefore, the sham training sessions were minimally shorter than the AAT training sessions (192 vs. 216 trials). To compute the approach bias score for each training session, we used the average response times (RTs) from the 96 smoking-related images (mean RT to the 24 incompatible smoking trials minus mean RT of the 48 compatible trials). Positive values again indicate a smoking-approach tendency, whereas negative values indicate a smoking-avoidance tendency.

Data Analysis

Multilevel modeling (MLM) was used to estimate the growth curve for approach bias over time (from baseline to session 4; 5 assessments). MLM is an intent-to-treat analysis that includes all participants, regardless of missing data, thereby increasing power and generalizability. Since approach bias decreased rapidly and then leveled off, we followed the procedure recommended by Heck, Thomas, & Tabata (2013) and others to compare various curvilinear functions of Time (quadratic, logarithmic, hyperbolic) to best fit the data. The model using a hyperbolic function of Time had the best fit. This model showed a fast initial decrease in approach bias, followed by a rapid leveling off.

To test for treatment group differences in reductions in approach bias over time (hypothesis 1), our MLM model included Treatment, Time (hyperbolic time, centered at

end of treatment), and Treatment x Time as predictors of approach bias. To examine whether baseline approach bias moderated the effect of treatment on change over time (hypothesis 2), we added baseline approach bias, baseline approach bias x Treatment, and baseline approach bias x Treatment x Time to the model. Finally, we performed a regression analysis to determine if the rate of reduction in approach bias predicted length of abstinence after the quit attempt (hypothesis 3). In this analysis, number of days abstinent during the first week after the quit attempt (0-7) was predicted by reduction in approach bias, final approach bias score, treatment condition, baseline CO reading, and gender. This analysis was performed using Poisson regression and a log link function.

Post-hoc power analyses for the MLM models, performed using the MLM power analysis program PinT 2.12 (Snijders and Bosker, 1993), indicated that we had greater than .90 power to detect a medium effect size (d=.50) for hypotheses 1 and 2. For hypothesis 3, G*Power indicated that we had greater than .80 power to detect an effect size of exp(b)=1.62 for a standardized predictor (i.e., between a medium and a large effect size; Faul, Erdfelder, Lang, & Buchner, 2007).

Results

Sample Characteristics

As can be seen in Table 1, 52 participants were randomized to either AAT (n=29) or sham (n=23). Table 1 reports on demographic characteristics and clinical variables. A total of 49 individuals were included in the final analyses. Three participants' data had to be excluded because their responses on the approach bias assessment were unusually slow. Interestingly, the mean approach bias score at baseline was 10 ms (SD=144 ms), indicating that many participants did not present with a substantial approach bias. Also, approach bias scores at baseline were not correlated with any variables related to smoking (e.g., daily cigarette count, FTND scores; all p's>.05).

Table 1. Demographics and Baseline Clinical Characteristics

	AAT (*n*=29)			Sham (*n*=23)			Total Sample (*n*=52)		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
Age	29	34.3	11.0	23	38.2	12.6	52	36.0	11.8
Cigarettes/day	29	14.8	7.7	23	12.4	6.3	52	13.7	7.1
CO reading (ppm)	29	15.1	8.1	23	15.8	12.4	52	15.4	10.2
FTND	29	4.5	2.6	23	4.1	2.3	52	4.3	2.4
Motivation to Quit Smoking	29	8.0	1.7	23	8.3	1.7	52	8.1	1.6
Approach Bias	28	0.5	123.5	21	23.0	170.5	49	10.1	144.3

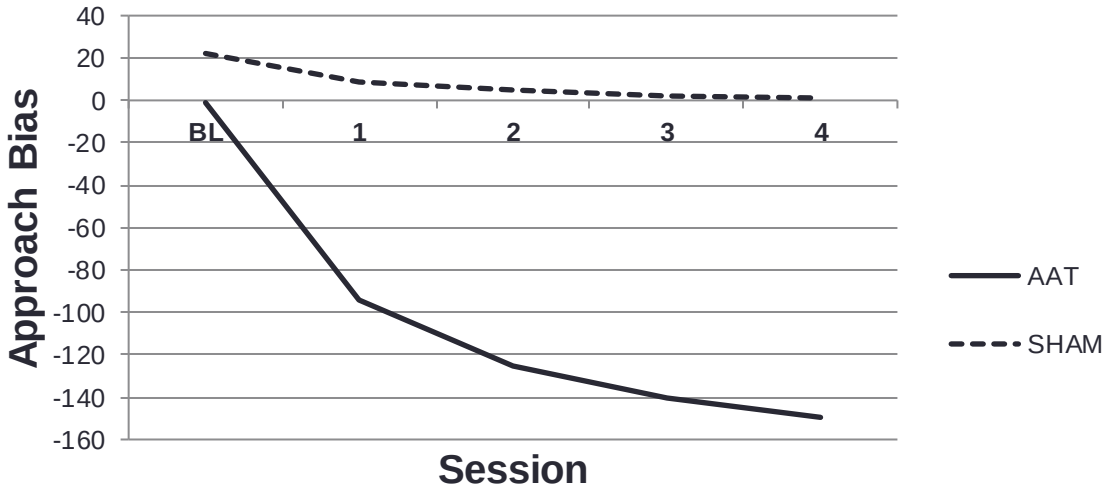
	N	*%*	*N*	*%*	*N*	*%*
Gender (Female)	15	51.7	14	60.9	29	55.8
Education (some college)	25	86.2	22	95.7	47	90.4
Married	6	20.7	4	17.4	10	19.2
Ethnicity (Hispanic or Latino)	1	3.4	4	17.4	5	9.6
Race						
White	22	75.9	19	82.6	41	78.8
Black or African American	3	10.3	3	13.0	6	11.5
Asian	2	6.9	1	4.3	3	5.8
Native Hawaiian or Pacific Islander	1	3.4	0	0.0	1	1.9
Other	1	3.4	0	0.0	1	1.9

Note:
CO = Carbon monoxide; ppm = parts per million; FTND = Fagerström Test of Nicotine Dependence

Hypothesis Testing

Consistent with hypothesis 1, our MLM analysis revealed a significant Treatment x Time interaction (b=159.3, t(47)=2.65, p=.011, d=.77; see Figure 1). Participants in the AAT condition evidenced greater declines in approach bias over time than those in the control condition. Hence, participants in AAT had significantly lower approach bias at the end of treatment than those in the control condition (b=150.7, t(45)=4.23, p<.001, d=1.26).

Figure 1. AAT outperforms sham on approach bias reduction over time.



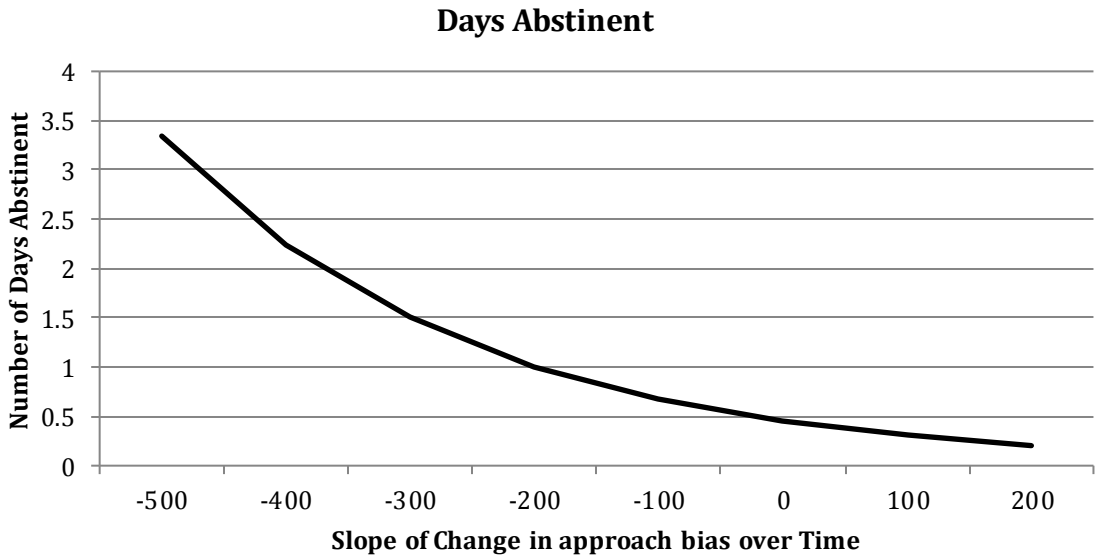
Baseline approach bias did not moderate the effect of treatment on approach bias (hypothesis 2): neither the baseline approach bias x Treatment x Time interaction nor the baseline approach bias x Treatment interaction (at the end of treatment) was significant (ps>.41). However, there was a significant interaction between baseline approach bias scores and time (b=-.98, t(90)=-4.25, p<.001, d=.90), such that participants with higher

baseline approach bias decreased their approach bias more than those with lower baseline approach bias.

To determine whether change in approach bias over time or approach bias score at end of treatment predicted days abstinent after quit date, we first calculated the estimated hyperbolic slope of change over time and the estimated intercept at end of treatment for each participant, using MLM. These predictors, along with treatment condition, baseline CO, and gender, were then included in a Poisson regression predicting number of days abstinent. This analysis included the 40 completers in the study, since these were the only participants from whom abstinence data was available. The Poisson regression indicated that greater decreases over time in approach bias were related to more days abstinent after the quit attempt (b=-.004, $\chi^2(1)$=4.56, p=.033, d=.72; see Figure 2.). Baseline CO and sex also emerged as significant predictors such that there were more days abstinent for those with lower CO (b=-.94, $\chi^2(1)$=7.67, p=.006, d=.97), and for men (b=-.65, $\chi^2(1)$=5.76, p=.016, d=.82). Finally, neither the level of approach bias at the end of treatment (b=.54, $\chi^2(1)$=2.14, p=.143, d=.48) nor treatment condition (b=-.13, $\chi^2(1)$=.25, p=.614, d=.16) were significant predictors of days abstinent.

In an exploratory analysis, we found that treatment condition was not significantly related to days abstinent when the slope of improvement in approach bias and the level of approach bias at end of treatment were excluded as predictors of days abstinent in the Poisson regression (b=-1.10, $\chi^2(1)$=.59, p=.442, d=.25).

Figure 2. Approach bias slope related to days abstinent.



Discussion

The current study examined whether four sessions of approach bias modification led to a reduction in approach bias among a sample of motivated treatment-seeking smokers and whether the reduction in approach bias was associated with initial quit success following a self-guided quit attempt. Consistent with study hypotheses, participants assigned to the AAT condition evidenced significantly greater reduction in approach bias relative to those assigned to the sham condition. As expected, the AAT training created a smoking-avoidance bias in participants, which decreased from the first to the fourth training session. Also as expected, the sham training condition created a neutral bias by training participants to both pull and push smoking pictures.

Before training, the average approach bias exhibited by all participants was quite small (10 ms). For these motivated smokers, smoking-related stimuli will be ambivalent, evoking both approach and avoidance tendencies. This replicates findings for treatment-seeking, abstinent alcoholics who did not show a strong approach tendency for their drug either (e.g., Eberl et al., 2013).

In our study, individuals with high levels of approach bias at baseline evidenced greater improvement in approach bias over time; however, baseline approach bias did not emerge as a moderator. Our findings suggest that the amount of reduction may be more important than the size of the pre-existing bias when it comes to clinically relevant outcome variables. This finding is inconsistent with some other cognitive bias modification research (Amir et al., 2011), but replicates findings of approach bias modification research in alcoholic inpatients reported by Eberl et al. (2013). Most importantly, a reduction in

approach bias during the intervention period was associated with a greater number of days abstinent in the week following a self-guided quit attempt. Collectively, these findings suggest that a brief intervention targeting approach bias may be beneficial in the treatment of smoking cessation, extending the results reported by Machulska et al. (2016) and complementing the literature on approach bias modification in alcohol addiction (Eberl et al., 2013; Wiers et al., 2011).

Previous trials have successfully applied this technique as an add-on intervention in inpatient settings (Eberl et al., 2013; Machulska et al., 2016, Wiers et al., 2011). To our knowledge, this is the first study to test a brief approach bias modification stand-alone intervention among a sample of treatment-seeking smokers. While our brief intervention was effective in reducing the approach bias, the direct effect of treatment condition on abstinence was small (d=.25) and did not reach statistical significance. One possible reason may be the relatively small sample in this pilot study. In addition, the sham training may be more effective than assumed. Namely, the 50% smoking-avoidance trials might constitute a weaker dosage of the AAT training, rather than a no-training condition. Thus, while the AAT training should be better at taming the "horse", the sham training may actually strengthen the "rider".

Future work should employ the approach bias modification intervention within the context of a dose-response design. It would also be important to examine mechanisms by which cognitive bias training can improve the quit success. It could be that reducing approach bias helps to alleviate craving or urge to smoke. An additional important next step would be to pair this intervention with a traditional long-term smoking cessation

program (Machulska et al., 2016). Such combination approaches are supported by dual process models and empirical evidence (Wiers et al., 2013a).

There are several limitations that warrant consideration. While we observed a relation between approach bias reduction and an index of smoking cessation success, a longer follow-up period is warranted. An additional caveat is that we could be seeing carry-over effects from training to approach positive stimuli, rather than solely training to avoid smoking images. Although trainings involving the approach of positive images may be particularly therapeutic in itself (see Becker et al., 2016), future studies may employ smoking-matched control stimuli (e.g., an individual holding a pencil to the lips) in order to disentangle these effects. A final limitation concerns the nature of self-report data - participants may be unwilling to be truthful or lack insight into their daily cigarette count. We sought to ameliorate this risk by telling participants that we were performing biochemical verification of their smoking status, but there are still risks for inaccurate reporting (Man et al., 2009; Shipton et al., 2009; West, Zatonski, Przewozniak, & Jarvis, 2007).

Overall, the current study suggests that a reduction in approach bias may facilitate a smoking cessation success. This lends support to the emergent literature and calls for research testing multi-component, integrative treatments for smoking cessation.

References

Amir, N., Taylor, C. T., & Donohue, M. C. (2011). Predictors of response to an attention modification program in generalized social phobia. *Journal of consulting and clinical psychology*, 79(4), 533. http://dx.doi.org/10.1037/a0023808

Ashare, R. L., Wileyto, E. P., Perkins, K. A., & Schnoll, R. A. (2013). The First Seven Days of a Quit Attempt Predicts Relapse: Validation of a Measure for Screening Medications for Nicotine Dependence. *Journal of addiction medicine*, 7(4), 249. http://dx.doi.org/10.1097/adm.0b013e31829363e1

Becker, E.S., Ferentzi, H., Ferrari, G., Möbius, M., Brugman, S., Custers, J., Geurtzen, N., Wouters, J., & Rinck, M. (2016). Always approach the bright side of life: A general positivity training reduces stress vulnerability in vulnerable individuals. *Cognitive Therapy and Research*, 40, 57-71. http://dx.doi.org/10.1007/s10608-015-9716-2

Cousijn, J., Goudriaan, A. E., & Wiers, R. W. (2011). Reaching out towards cannabis: approach- bias in heavy cannabis users predicts changes in cannabis use. *Addiction*, 106(9), 1667-1674. http://dx.doi.org/10.1111/j.1360-0443.2011.03475.x

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? *Developmental cognitive neuroscience*, 4, 38-51. http://dx.doi.org/10.1016/j.dcn.2012.11.002

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, 39(2), 175-191. http://dx.doi.org/10.3758/bf03193146

Ferguson, S. G., Gitchell, J. G., Shiffman, S., & Sembower, M. A. (2009). Prediction of abstinence at 10 weeks based on smoking status at 2 weeks during a quit attempt: secondary analysis of two parallel, 10-week, randomized, double-blind, placebo-controlled clinical trials of 21-mg nicotine patch in adult smokers. *Clinical therapeutics*, 31(9), 1957-1965. http://dx.doi.org/10.1016/j.clinthera.2009.08.029

Field, M., Kiernan, A., Eastwood, B., & Child, R. (2008). Rapid approach responses to alcohol cues in heavy drinkers. *Journal of behavior therapy and experimental psychiatry*, 39(3), 209-218. http://dx.doi.org/10.1016/j.jbtep.2007.06.001

Fiore, M. C., Jaen, C. R., Baker, T. B., Bailey, W. C., Benowitz, N., & Curry, S. J. (2008). Treating tobacco use and dependence: 2008 update US Public Health Service Clinical Practice Guideline executive summary. *Respiratory care*, *53*(9), 1217-1222.

Friese, M., Hofmann, W., & Wiers, R. W. (2011). On taming horses and strengthening riders: Recent developments in research on interventions to improve self-control in health behaviors. *Self and Identity*, 10(3), 336-351. http://dx.doi.org/10.1080/15298868.2010.536417

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & FAGERSTROM, K. O. (1991). The Fagerström test for nicotine dependence: a revision of the Fagerstrom Tolerance Questionnaire. *British journal of addiction*, 86(9), 1119-1127. http://dx.doi.org/10.1111/j.1360-0443.1991.tb01879.x

Heck, R. H., Thomas, S. L., & Tabata, L. N. (2013*). Multilevel and longitudinal modeling with IBM SPSS*. Routledge. http://dx.doi.org/10.4324/9780203701249

Heuer, K., Rinck, M., & Becker, E. S. (2007). Avoidance of emotional facial expressions in social anxiety: The Approach–Avoidance Task. *Behaviour research and therapy*, 45(12), 2990-3001. http://dx.doi.org/10.1016/j.brat.2007.08.010

Machulska, A., Zlomuzica, A., Adolph, D., Rinck, M., & Margraf, J. (2015). "A cigarette a day keeps the goodies away": Smokers show automatic approach tendencies for smoking-, but not for food-related stimuli. *PLoS one* 10(2): e0116464. http://dx.doi.org/10.1371/journal.pone.0116464

Machulska, A., Zlomuzica, A., Rinck, M., Assion, H. J., & Margraf, J. (2016). Approach bias modification in inpatient psychiatric smokers. *Journal of Psychiatric Research*, 76, 44-51. http://dx.doi.org/10.1016/j.jpsychires.2015.11.015

Man, C. N., Fathelrahman, A. I., Harn, G. L., Lajis, R., Samin, A. S. M., Omar, M., ... & Bayanuddin, N. A. (2009). Correlation between urinary nicotine, cotinine and self-reported smoking status among educated young adults. *Environmental toxicology and pharmacology*, 28(1), 92-96. http://dx.doi.org/10.1016/j.etap.2009.03.003

Perkins, K. A. (2014). Improving efficiency of initial tests for efficacy in smoking cessation drug discovery. *Expert opinion on drug discovery*, 9(11), 1259-1264. http://dx.doi.org/10.1517/17460441.2014.951632

Shipton, D., Tappin, D. M., Vadiveloo, T., Crossley, J. A., Aitken, D. A., & Chalmers, J. (2009). Reliability of self reported smoking status by pregnant women for estimating smoking prevalence: a retrospective, cross sectional study. *Bmj*, 339, b4347. http://dx.doi.org/10.1136/bmj.b4347

Snijders, T. A., & Bosker, R. J. (1993). Standard errors and sample sizes for two-level research. *Journal of Educational and Behavioral Statistics,* 18(3), 237-259. http://dx.doi.org/10.3102/10769986018003237

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: a tool for explaining paradoxical behavior. *Annual review of clinical psychology*, 6, 551. http://dx.doi.org/10.1146/annurev.clinpsy.121208.131444

US Department of Health and Human Services. (2014). The health consequences of smoking—50 years of progress: a report of the Surgeon General. *Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health*,17. http://dx.doi.org/10.1037/e510072014-001

West, R., Zatonski, W., Przewozniak, K., & Jarvis, M. J. (2007). Can we trust national smoking prevalence figures? Discrepancies between biochemically assessed and self-reported smoking rates in three countries. *Cancer Epidemiology Biomarkers & Prevention*, 16(4), 820-822. http://dx.doi.org/10.1158/1055-9965.epi-06-0679

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological science*, 22(4), 490-497. http://dx.doi.org/10.1177/0956797611400615

Wiers, C. E., Kühn, S., Javadi, A. H., Korucuoglu, O., Wiers, R. W., Walter, H., ... & Bermpohl, F. (2013b). Automatic approach bias towards smoking cues is present in smokers but not

in ex-smokers. *Psychopharmacology*, 229(1), 187-197. http://dx.doi.org/10.1007/s00213-013-3098-5

Wiers, R. W., Gladwin, T. E., Hofmann, W., Salemink, E., & Ridderinkhof, K. R. (2013a). Cognitive bias modification and cognitive control training in addiction and related psychopathology mechanisms, clinical perspectives, and ways forward. *Clinical Psychological Science*, 2167702612466547. http://dx.doi.org/10.1177/2167702612466547

Wiers, R. W., Rinck, M., Kordts, R., Houben, K., & Strack, F. (2010). Retraining automatic action- tendencies to approach alcohol in hazardous drinkers. *Addiction*, 105(2), 279-287. http://dx.doi.org/10.1111/j.1360-0443.2009.02775.x

Wileyto, E. P., Patterson, F., Niaura, R., Epstein, L. H., Brown, R. A., Audrain-McGovern, J., ... & Lerman, C. (2004). Do small lapses predict relapse to smoking behavior under bupropion treatment? *Nicotine & tobacco research*,6(2), 357-367. http://dx.doi.org/10.1080/1462220042000202463

Zhou, X., Nonnemaker, J., Sherrill, B., Gilsenan, A. W., Coste, F., & West, R. (2009). Attempts to quit smoking and relapse: factors associated with success or failure from the ATTEMPT cohort study. *Addictive behaviors*, 34(4), 365-373. http://dx.doi.org/10.1016/j.addbeh.2008.11.013